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Uranium and Vanadium

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URANIUM AND VANADIUM

By Siegfried Fischer

Uranium.—Up to the present time uranium is of commercial value only as far as its radium content is concerned. Besides radium most of the uranium ores carry other radio-active substances such as actinium, polonium and ionium. At the Gif works in France, ores containing these elements are treated so as to obtain them separately. Outside of the chemicals uranium has a small field of usefulness. It is used to some extent in the glass and porcelain industry as a coloring medium. A German firm is putting on the market ferro-uranium to be used in the manufacture of steel. England is also interested in uranium steels and, as a permanent supply of ferro-uranium is guaranteed by Messrs. Geo. G. Blackwell, Sons & Co., Ltd., of Liverpoool, trials on a larger scale will be made in the steel industry. The reason for the lack of interest shown to the use of uranium in making steel was mainly due to the fact that the cost of production of ferro-uranium was far above that of ferro-tungsten. The properties of uranium and tungsten steels being similar, and the cost of ferro-tungsten being less, uranium could not compete with its rival. Uranium is also being used in the manufacture of organic dyes. It has been found that organic dyes containing the hydroxyl group will form new dyes with UO_2. The quantity of uranium used for all these purposes is, however, far below the amount that could be supplied and it is a desireable thing to find new commerical uses for this element.

Sources.—New deposits of uranium-bearing minerals are few. It is said that some pockets of uranium ore have been found on the ground of the Minnesota-Nevada Copper Mining Co., at Wabuska, Nev. Also some new veins of ore carrying autunite and tobernite have been located in the Schwarzwald, Germany. The main sources of uranium are as in previous years, pitchblende and carnotite. It is of interest to know, that during the year 1913 a definite formula for carnotite has been found. It has the following structure: $(Ca, K_2)\ (UO_2)_2\ (VO_4)_2$ and contains 18 per cent. U_3O_8 and 56 per cent. V_2O_5. Much prospecting is being done to find new minerals containing uranium. The Canadian Government has offered as an inducement $25,000 for the discovery of new ores containing uranium, in the Dominion.

Technology.—In an article published in the June, 1912, number of *Metallurgical and Chemical Engineering*, the necessity and means of

concentrating carnotite ores was published for the first time by S. Fischer. That this was possible and necessary was again shown by the work done by the Bureau of Mines, which is published in *Bulletin* 70 which gives with considerable detail all the known processes for the obtaining of the uranium for further treatment for radium, and as they are not new, no further mention will be made regarding them.

Market.—The steady demand for radium is increasing the demand for uranium ores. The American market is paying on the basis of the uranium content only and has raised the price per unit of U_3O_8 so as to allow for any vanadium in the ore. The price varies per pound from $1.00 for an ore carrying 0.6 per cent. of U_3O_8 to $4.60 for one carrying 3.15 per cent. U_3O_8. A German firm claims to have bought pitchblende ore running 30 per cent. pitchblende at $0.81 a pound. The slimes obtained from the treated ore in Portugal sell from $22 to $30 a ton.

United States.—The following mines are producing pitchblende to date: the German and Belcher mines, the Kirk, Wood and Calhoun mines in Gilpin Co., Colo. The carnotite deposits commercially producing are those of the Paradox Valley, and surrounding districts, Colo., and the Green River district in Utah.

Production: Ore shipped in terms of U_3O_8 and metallic U.

1911	25 tons	21.2 tons
1912	26 tons	22.0 tons
1913	38 tons	32.3 tons

The figure for 1913 shows an increase of nearly 50 per cent. The output would have been greater had not one of the principal foreign producers had to restrict its operations due to the factory at Liverpool not having been completed.

Australia.—Production between 4 and 5 tons of pitchblende.

VANADIUM.—The increasing demand for vanadium for the making of vanadium steels is adding importance to this metal. Besides its beneficial qualities in the metallurgy of steel, it has attained not a little importance in the medical field. Under the name of vanadin, a double salt of vanadium with postassium chlorate is being used as a medicine. With aniline it is used as a brick dye. V_2O_5 replaces platinum as a catalyte in the contact process for sulphuric acid. It is used as a developer in photography. Vanadium chloride is used as a mordant. Vanadates with tannic acid give a waterproof black ink, and vanadium salts are used as coloring agents in the glass industry.

These uses are however small compared with the use of vanadium in the steel industry. The beneficial properties ascribed to its use in steels are great toughness and increased torsional strength. It is therefore

alloyed with steels used for automobile parts, gears, piston rods, tubes, boiler plates, tires, transmission shafts, bolts, gun barrels, gun shields, and forgings of any kind requiring heavy wear and tear. The amounts of vanadium used for such steels varies from 0.1 to 0.4 per cent. Other alloys with vanadium are bronzes and german silver used for castings. In cast iron vanadium increases the strength 10 to 25 per cent.

Sources.—Three quarters of all the vanadium produced is made from patronite, an impure VS_3 mined in Peru by the American Vanadium Co. The hardness of this mineral is 2.5 and its specific gravity 2.65 to 2.71. The ore contains 20 to 30 per cent. V_2O_5, and when roasted the V_2O_5 content is raised to 40 per cent. Typical analyses of the ore are by

K. Smith.	Per Cent.
VS_3	39.8
MoS_2	1.6
NiS	1.5
FeS_2	4.1
S	30.6

Handy.	Per Cent.
V	16.0
MoO_3	0.5
Fe	2.5
S	54.1

Hillebrand.	Per Cent.
V	19.5
Mo	0.2
Ni	1.9
Fe	2.9
S	58.8

The Peruvian deposits are located at Quisque, Minasragra, Province Pasco, Department Junin. They cover an area 3.5 by 1.5 miles, and are 16,000 ft. above sea level.

Vanadium is also obtained in considerable quantities from carnotite. A further source of vanadium are the vanadinite deposits of San Marta, Estramadura, Spain. At present very little is being done with the vanadinite deposits in Grant County, New Mexico. The last commercial sources are the vanadiferous sandstone deposits of Colorado and the roscoelite at Newmire, Colo. Due to the Peruvian ore roscoelite is losing in importance as a commercial vanadium ore.

The ashes of some coals show an appreciable amount of vanadium:

Coal Deposits in	Per Cent. Ash.	Per Cent. V_2O_5 in Ash.
Peru: Yauli	7.56	3.87
Chile: Iqique	3.50	16.4
Argentine Rep.: Mendoza	0.63	38.2
United States: Oklahoma	1.03	19.3

The ashes of the Peruvian coals are being sold but their sale is slowing up due to the activities of the American Vanadium Co. in Peru.

Vanadium is also found in Mexico, Australia and Portugal, but none of the minerals found are commercially utilized. Some mineral oils of America, Peru and Argentine show vanadium.

Technology.—The process devised by W. F. Bleeker for the extraction of vanadium from patronite is as follows: ore is pulverized, then mixed with a flux which will render the vanadium soluble after roasting; the roasted

product is leached with water giving the vanadium as vanadates or vandyl salts. The residue is leached with dilute acid to dissolve any insoluble vanadium compounds, and the solutions are mixed to obtain a neutral solution. Copper sulphate or any other copper salt is added to the solution and this precipitates the vanadium as copper vanadate which is filtered out. It is then reduced to ferro-vanadium.

Method used by the Primos Chemical Co. at Newmire, Colo.: the ore is weighed and mixed with salt. This mixture is then coarsely ground and dried down to 1 per cent. moisture in a drier. The somewhat caked material is then ground to 20 mesh and roasted in a furnace for 3 hours. From the bottom of the furnace the product is conveyed to leaching vats where it is leached with water. The solution containing the vanadium as vanadate is then treated with ferrous sulphate giving vanadate of iron. This is filtered off, dried and shipped to Pennsylvania where it is reduced to ferro-vanadium.

Ferro-vanadium:	25 to 50 per cent.	V	made by the Société
	0.3 to 5	C	Electro-Metallurgique.
Ferro-vanadium:	30 to 35	V	Goldschmidt Thermite Co.
	No	C	

Ferro-vanadium with 33 per cent. V melts with Fe at 1400 C.
Commercial Alloys: 97 Cu and 3 V.
Ni and 18–25 V.
Aluminium bronze: 0.5 V, 94.5 Cu, 0.5 Al.
Manganese bronze: 0.03 V, 58.6 Cu, 38.5 Zn, 14.8 Al, 0.48 Mn.
Manganese bronze: 1.0 Fe.

Market.—The market price of ferro-vanadium is $2.50 per pound of vanadium contents. Vanadium ore running 15 per cent. V_2O_5 sells per ton, minimum, $150 and maximum, $180.

Ore has been offered on the German market at $2.38 per kilo (2.2 pounds). The ore is claimed to come from Peru.

All the vanadium ores of commercial value come from Peru, the United States and Spain. The ore from Peru is treated in America, by the American Vanadium Co., who control the market.

United States.—The vanadium shipped in the ores for the year 1913 was 914 tons of V_2O_5 which is equal to 412 tons of vanadium metal. The production of ferro-vanadium has increased 24 per cent. It costs approximately $70.00 to mine and deliver 1 ton of carnotite ore in Europe.

The chief ore producers are: the American Vanadium Co., Primos Chemical Co., Colorado Carnotite Co., Curran & Hudson Co., Standard Chemical Co., McKeever & Co., Arden Wilson & Co., and the General Vanadium Co.

Peru.—According to a reliable source the output of ore from Peru was somewhat restricted for the year 1913. The crude ore before being

shipped to America is calcined, raising its vanadium content to between 40 and 50 per cent. V_2O_5.

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